WESTERN POND TURTLE: SURVEY PROTOCOL AND MONITORING PLAN
To append to Conservation Strategy

by

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PREFACE

This document was prepared by the Survey and Monitoring Task Group under the Interagency Western Pond Turtle Working Group, which is an informal committee of interested biologists and managers. It is intended to be the first module leading to an eventual conservation assessment and strategy for the western pond turtle (*Clemmys marmorata*).

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I. INTRODUCTION

The Western Pond Turtle (WPT) (*Clemmys marmorata*), is listed as "Sensitive-Critical," by Oregon, "Endangered" by Washington, "Species of Special Concern" by California, "Sensitive" by the U.S. Forest Service in Regions 5 and 6, "Species of Special Concern" by the Bureau of Land Management, and "Species of Concern" by the U.S. Fish and Wildlife Service. The WPT historically ranged from the vicinity of Puget Sound in Washington to the Sierra San Pedro Martirs in Baja California Norte, chiefly west of the Sierra-Cascade crest. There are estimates that population declines may be occurring over 80% of its range (Holland, 1994; Hayes 1999). Declines are most dramatic in the northern and southern portions of its range (Washington and southern California) where many populations have been lost (Holland and Bury, in press). Habitat loss and alteration, isolation of populations, introduction of non-indigenous species, and pollution are some factors known to negatively affect WPT populations (Holland and Bury, in press).

Western pond turtles are long lived and may reach an age of 30 years or more in the wild. However, only a few reach old age and they appear to have low recruitment rates. Female WPTs in northern populations do not mature to reproductive age until 7-14 years old (Holland and Bury, in press). These population features are important to consider when designing a monitoring plan and for effective conservation strategies for the species.

Small, incremental changes in population condition can result in species declines or local extirpation. Adult WPTs may be observed many years after a population has fallen below the threshold of viability (i.e., low or no recruitment). However, hatchling and young turtles are difficult to observe in the wild, often are solitary, and usually under sampled (R.B. Bury, pers. observ.). Thus, sampling of WPTs will require innovative techniques and a long-term commitment of resources.

GOALS AND OBJECTIVES

The goal of the Interagency Western Pond Turtle Working Group is to recover and stabilize the northwestern pond turtle (NWPT) (Clemmys marmorata marmorata) populations by removing or reducing threats to the species and its habitat. These measures may help prevent the need to list the pond turtle as threatened or endangered. A substantial proportion of this species' habitat does not occur on public lands. Clearly, there is a need for State and Federal agencies, and interested citizens and landowners to join in efforts to monitor and protect this species throughout its range. Monitoring should employ scientifically valid methods yet achieve the greatest possible efficiency. Consistency in data collection is necessary to allow consolidation and analysis of information from different geographic areas (Anderson, 1999).

Development of this sampling protocol is based on a variety of sources: published research papers on the species, unpublished reports, and general knowledge of pond turtles by individuals in the Working Group. Insight and specific information on sampling techniques were gained from field tests during Pilot Studies on the turtle in the Umpqua River basin, Oregon, in 1997-00, and elsewhere. The main focus of the interagency group was on the northern subspecies, but we hope the protocol can be readily adapted to other geographical areas within the range of the WPT and,

perhaps, other species. We would appreciate feedback on its utility.

The specific objectives for the project were to: (1) Determine the current status of NWPT distribution; (2) Detect significant change in population and habitat condition; and (3) Monitor long term trends in distribution, relative abundance and other demographics of turtle populations.

NEED FOR SURVEY AND MONITORING PROTOCOLS

The purpose of field surveys is to determine the presence of NWPTs, to estimate their relative abundance and to provide baseline information on population and habitat condition. The survey protocol is also designed to be used as a tool for project or management action impact assessments (e.g., construction of a bridge over a stream, road construction).

The primary purpose of field monitoring is to detect significant change in the population demographics and species habitat, and to determine whether management and conservation efforts are successful. Monitoring is needed to assess the effectiveness of conservation efforts and identify factors affecting achievement of conservation objectives. Monitoring design must attempt to identify the primary causal factors of change in distribution, numbers and population features of NWPTs. Ideally, monitoring would occur early enough to allow time for corrective actions to be taken that would prevent the need toward listing of the species. This protocol should help achieve consistency, efficiency, and lack of bias in monitoring and surveying across the range of the NWPT.

II. SYNOPSIS OF BIOLOGY

Because a basic understanding of the biology and behavior of the NWPT is important when conducting field studies, the following biological information is summarized (from Holland 1994; Holland and Bury in press).

BEHAVIOR

The NWPT have keen sight and hearing, and they are especially sensitive to movement. They may spend a considerable amount of time in thermoregulatory behavior such as emergent basking on logs or rocks and aquatic basking (e.g., resting in upper thermal layers found in algal mats). Pond turtles may be active year round in the southern part of their range, but are inactive where winters are cool or cold. Even in the northern part of their range, they may occasionally engage in emergent basking during sunny winter days. Turtles may overwinter in the mud at the bottom of ponds, sometimes communally. In streams and rivers, turtles move up to 500 m or more into upland habitats where they to burrow into duff and overwinter (Reese and Welsh, 1997). Movement to overwintering sites occurs from September to November, while emergence from terrestrial overwintering sites occurs from March to June. Occasional overland movements (usually less than 3 km) occur, but movement between drainages is probably uncommon.

DIET AND HABITAT REQUIREMENTS

NWPTs are dietary generalists, locating food by sight or smell. The majority of their diet consists of small aquatic invertebrates, while carrion may occasionally be consumed. In some ways, the NWPT is a habitat generalist. They can be found from sea level up to 1370m (4500 ft), or even at higher elevations in the southern part of their range. They occur in rivers, streams, lakes, ponds, reservoirs, stock ponds, and permanent and ephemeral wetland habitats. However, NWPTs tend to aggregate where certain conditions exist: quiet waters, cover, and basking sites. For example, an ideal site would be a deep pool along a small river with boulders and fallen trees (or brush piles). Intervening riffles and shallows are likely used only for movement between pools or foraging.

REPRODUCTION

The size and age at first reproduction varies with geographic range, with most female turtles in northern populations reaching sexual maturity at greater than 120 mm carapace length (shell) and 8-10 years of age. In southern populations, turtles mature at about 100 mm carapace length and 4-6 years of age. The clutch size varies from 1-13 eggs, with an average of 7 in the Willamette Valley, Oregon.

Females usually deposit eggs from May through July. The female generally leaves the watercourse in the evening and moves into upland habitats to excavate a nest. Known nest sites have been located an average of about 50 - 80 m from the watercourse, with most occurring within 100 - 150 m (Holland 1994; Holte 1998). Some nests are deposited up to 500 m away from water.

Nests are typically excavated in compact, dry soil with high clay or silt fraction, usually in areas with short grasses or forbs. Aspect is usually south or west facing and on a slope of 25 degrees or less. Incubation usually ranges from 80-105 days in the northern part of the range and the hatchlings overwinter in the nest and emerge in the spring. Raccoons, skunk, and coyotes are known to prey on nests. It is possible that over 95% of the nests are destroyed by predators in some areas. However, we know little of the nesting success of this species.

GROWTH

Growth rates vary geographically, with most hatchlings being 25-32 mm in carapace length upon emergence from the nest. Holland (1985) found that the average size for turtles on the central California coast was: 1 yr = 67 mm, 2 yr = 90 mm, 3 yr = 98 mm, 4 yr = 109 mm, and each successive year an additional 5 mm of growth occurred. Bury and Germano (1998) found the average size of turtles in northern California to be: 0 yr = 33 mm, 1 yr = 52 mm, 2 yr = 67 mm, 3 yr = 78 mm, 4 yr = 88 mm, 5 yr = 95 mm, 6 yr = 103 mm, 7 yr = 107 mm, and then about 7 mm of growth per year for the next 3 years when growth seemed to slow appreciably. These data indicate that a turtle in central California takes 4 years to reach 109 mm, but a northern California turtle requires about 7 years to reach the same size. Turtles in southern latitudes such as the San Joaquin Valley may reach this size in 3 years (D. Germano, pers. observ.).

SURVIVAL

Most losses of turtles are in the nest, which is subject to predation by a variety of mammals and other species. Survival may be low for age classes 1-3. Survivorship after the adult size is reached (>120 mm carapace length) may be >90% annually. The maximum lifespan is unknown, but some turtles may live to be over 40 years old in the wild.

Many species prey on turtles, especially on the smaller turtles. Known predators include bullfrogs, fish, osprey, eagles, raccoon and coyotes. The effects of predation by introduced species such as bullfrogs and largemouth bass may be significant. Another concern is the possible introduction of parasites or pathogens from introduced species of turtles.

HUMAN IMPACTS

In the past, NWPTs were collected in large numbers for the pet trade and as food. These practices are now illegal (State regulations). Today, loss and alteration of aquatic and upland habitat are the most detrimental factors to NWPT populations. NWPTs require water and human needs have modified most waterbodies (e.g., reservoirs and canals replacing marshlands). Localized human activities such as traffic on roadways and railroads adjacent to waters occupied by the turtle and spilled contaminants may pose a threat to turtles.

VIII. MONITORING BY VISUAL SURVEYS (Fit into Conservation Strategy at section VII)

BACKGROUND

Some researchers have questioned the use of visual surveys to determine the relative abundance of turtles (Germano and Bury 2000). However the methods used for visual surveys is usually very inconsistent regarding survey duration, time of year, and number of replicates (Nordby 1992, Germano and Bury 2000, Holland 1994, Bury 1972). Data from the Umpqua basin (Horn unpub data) have indicated that repeat visits during optimal survey times and seasons would most likely improve the accuracy of the visual data. The Umpqua data determined that 3 visits per year for 2 years gives reasonably accurate and consistent trend estimates regarding turtle abundance. They determined that fewer replicates severely underestimated the number on non-adult age turtles. The visual survey data should be used primarily as trend data, any attempt to correlate it to population demographics such as density and age structure should be done on a limited basis where comparison data from captures has been collected.

Lindeman (1997) compared spotting scope surveys using 8 replications (over 2 years) to trapping data on Cooters in Mississippi and Kentucky. He concluded that the results from visual surveys did not differ from trapping results. Due to the likelihood that larger datasets will be compiled with less time and effort, he recommended that replicated basking surveys should be considered in any widespread survey of the status of a basking emydid. Bury (1972) found that the number of turtles observed visually roughly equaled the number captured in pools by snorkeling.

Observations for his data were for 3-5 hrs duration each, so shorter periods likely would detect fewer turtles. In general, the number of turtles observed appear correlated to the number present. The maximum total of turtles detected visually at 3 pond sites in the Umpqua basin using standardized techniques (Horn unpub data) was a consistent percentage of the population estimate from captures, ranging from 40.3% to 53.5%. We agree with Lindeman (1997) and Jones and Hartfield (1995) in concluding that visual surveys are a valid survey technique and can be used as a rough index to population size.

In addition to standardizing the number of replicates, we need to clearly establish the optimal duration of surveys for counting basking turtles. In the Umpqua River Basin a 35-minute period of observation was determined useful in detecting most turtles basking. Longer observations at one site seldom yielded more turtles and less time tends to underestimate the number present, especially the non-adults (Sisk and Bury 1997, Horn 2000). In new survey areas, it is important to spend one day each month observing turtles at one or a few sites to serve as a calibration or reliability check. It may be possible to use remote cameras at sites to determine the optimal periods of basking.

OBJECTIVES

Two intensities of visual surveys may be used, depending on the information need and personnel available. Basic VIsual Surveys (BVIS) are useful to determine distribution, general population status and, on occasion, trends of the NWPT within and between river basins. BVIS are designed to ascertain quickly the number and distribution of individuals at the survey location or study area. However, more detailed information will be recorded if possible within the constraints of the survey design. BVIS are of limited use as a monitoring tool due to limited reliability of data collected and high potential for observer bias.

Another level of survey is called ENhanced VIsual Surveys (ENVIS) because it is more comprehensive than the basic visual survey. ENVIS is intended to provide more detailed population information: the number and size of individuals as well as making sex determinations. This will provide an indication of relative abundance as well as the ratio of adults to non-adults, which helps estimate population condition and trend. Sites selected for ENVIS usually comprise a smaller, randomly selected subset of the sites used for visual surveys.

SELECTION OF SAMPLE AREA

Sample areas are randomly selected from within a pool of eligible areas that comprise the study area. The study area should encompass complete watersheds when possible. The number of sample areas to be selected should be determined after carefully considering the total size of the area of eligibility, and time and resource constraints. Since riverine and pond sites have somewhat different eligibility criteria, they should be separated before individual sites are considered eligible. After sorting by site eligibility criteria, there is a smaller pool of potential survey areas. A map can then be created which displays regions or specific sites within the basin that have been classified as "eligible."

Since a list of randomly selected sample areas will almost certainly include sites where access is unavailable, it would be expedient to pre-select many more sample areas than can be surveyed. Then, when an inaccessible site is encountered, it can be removed from the sample area list, and replaced by another site on the list. The following criteria do not define the habitat boundaries of NWPT occurrence, importance, or significance. Sample area eligibility should be determined by a set of criteria that eliminate from the sampling pool those portions of the basin in which monitoring efforts would be inefficient. Following are descriptions of those criteria:

1. *Aquatic habitats*: Only aquatic habitats are to be a part of the sampling pool, terrestrial habitats should be removed from consideration.
2. *Accessibility*: Sections or areas that are inaccessible (e.g., private ownership where access is not granted or the owners cannot be contacted) will be removed from the sampling pool.
3. *Elevation*: Areas above 1300 m (4500 ft) sea level should be removed from the sampling pool.
4. *Stream order*: Any stream that is smaller than 4th order (usually <2 m across) should be removed from the sampling pool. This criterion should be applied primarily to projects in the northern latitudes of the subspecies. In more southern areas, such as the Sacramento Valley, NWPTs may occasionally be found in great abundance in lower order streams.
5. *Pond size*: Although small ponds may be quite productive, a lower size limit of 0.2 ha (0.5 ha) should be applied within basins with a large number of ponds. However, all waters may be included for better representation and to quantify what conditions are most suitable and less suitable for NWPTs if funding and logistics allow.

SELECTION OF SAMPLE SITES

Pond Sites

If all sites cannot be sampled, a predetermined proportion of the total number of known ponds, lakes, and reservoirs (hereafter referred to as ponds) within the study area should be randomly selected for sampling. Reservoirs that are seasonally drawn down, such as flood control reservoirs, appear to be poor turtle habitat and should be excluded. The sample area consists of the entire body of water. In ponds >3 ha (7.5 acres), more than 1 observation point should be selected due to the lack of complete coverage and because of habitat heterogeneity. Most ponds <3 ha will allow complete visual coverage of the waterbody, larger sites will need more observation points if complete coverage is required.

Riverine Sites

To more evenly distribute sample areas, while retaining randomness in the selection process, a predetermined number of sample areas per unit of linear distance of eligible streams in the basin area should be selected. For example, if there are two eligible streams within the study area and stream *A* and stream *B* have 70 and 30 km of eligible stream distance, respectively there is a total of 100 km total eligible stream distance. A sample point for every 10 km of eligible stream distance would result in a total of 10 sample sites selected, 7 within stream *A*, and 3 within stream *B*. Consider a sample point for every 20 km (12.5 mile) of stream as the minimum; more frequent sampling is preferred.

CLASSIFICATION OF SAMPLE SITES

It is important to understand how human impacts and natural habitat variables affect NWPT abundance and distribution so that we can minimize or prevent negative effects. Currently, we know little about these factors and, therefore when analyzing data we need a record of these habitat variables to allow stratification for comparison of different types of ponds and rivers. We have determined three types of classification for pond and riverine sites: (1) presence of non-indigenous species, (2) human influence criteria, and (3) habitat quality.

Non-indigenous Species

It has been postulated that non-indigenous species are detrimental to the NWPT (Holland 1994, Holland and Bury in press), therefore we need to determine the presence of any introduced species at a site. If a non-indigenous species is easily observable, presence is relatively easy to document. To determine absence of a species is more difficult and may require extensive sampling (visual, seining, and trapping) because some non-indigenous species are cryptic, nocturnal or elusive. The following species are common introductions in the Pacific States: bullfrogs (*Rana catesbeiana*), bass (*Micropterus* spp.), sunfish (*Lepomis* spp.), and catfish (*Ictalurus* spp.). There are several non-indigenous species of turtles such as sliders (*Trachemys scripta*) and cooters (*Pseudemys* spp.) that tend to be observed easily because they bask often. Other turtle species are mostly aquatic and are seldom observed, such as the common snapper (*Chelydra serpentina*) and softshell turtle (*Trionyx* and *Apalone* spp.).

Human Influence Criteria

This level of classification is used to determine the level of human use within an area and ranges from a natural condition to a heavily developed area. Finding a body of water that is in a truly "natural condition" is difficult because humans are drawn to water bodies for recreation, water use and industrial use. Thus, classifying a body of water into "natural condition" should be done in a relative sense and should be made based on the following criteria:

1. The body of water lies outside the corporate limits or major influence of any city or town.
2. There are no temporary (such as campgrounds) or permanent human habitations within 0.5 and 1 km of the body of water, respectively.
3. There are no major roads within 100 m of the body of water.
4. The substrate of the body of water is unaltered (i.e., no recent history of digging or dredging).
5. There are no agricultural activities nearby or above the body of water that would allow runoff (i.e., pesticides) to flow into the body of water.
6. There is little or no livestock grazing occurring within 500 m of the body of water.

Invariably, there will be some overlap in classification using these criteria so make the classification based on the influence that is the most prevalent at the site. These bodies of water may be sub classified:

1. *Natural, Forested:* Place into this sub-category if all the items above are satisfied and the immediate area surrounding the body of water is forested.
2. *Natural, Not forested:* Place into this sub-category if all the items above are satisfied and the immediate area surrounding the body of water is not forested.
3. *Light Human Development:* Place into this sub-category if only 1 of the first four items above is not satisfied.
4. *Heavy Human Development:* Place into this sub-category if 2 or more of the first four items above are not satisfied.
5. *Agricultural:* Place into this sub-category if the activity is major.
6. *Grazing:* Place into this sub-category if the activity is major.

Habitat Quality

Bodies of water can be classified based on the suitability of aquatic habitat for NWPT. Those habitat quality classifications may be considered from a range from unsuitable to favorable. Currently, it is difficult to formulate an objective set of criteria for classifying habitat into these categories that is also universally applicable. However, there are known or suspected habitat features that can serve as guidelines for making such classifications (Todd 1999, Reese 1996). Three major habitat features to consider are:

1. *Size of Water:* Large bodies of water tend to have low mean temperatures, and thus generally provide less suitable habitat for NWPTs than smaller bodies of water. A body of water that is relatively warm year-round or most of the year would provide favorable habitat quality for NWPTs (Dan Holland, pers. comm.).
2. *Depth of Water:* Water depth also gives some indication of habitat quality. Bodies of water where most of the system has a depth >2 m deep are less suitable as habitat than systems that are shallower. Depths less than 2 m provide accessible underwater refugia for turtles. Large ponds and large rivers have a considerable amount of open water in the center that is generally unsuitable for the NWPT.
3. *Basking structures:* An abundance of basking sites is often an indicator of suitable habitat quality, while an absence of such sites indicates lesser habitat quality (Bury 1972, Lindeman 1999). Emergent logs and rocks/boulders separated from shore are preferred basking sites, followed by such cover next to shore (especially over deep water). Fallen trees or brush piles may harbor many turtles. Emergent vegetation also provides some concealment. Shoreline basking areas are seldom used (unless there is deep water nearby or undercut banks), but there are exceptions (e.g., an open pond that is the last remaining water in an area).

Combining the 3 habitat features above will result in an overall habitat quality index. This index is somewhat subjective, but will increase the possibility of site comparisons in the future. For each habitat feature, if it meets the criteria assign a 1, if it does not meet the criteria assign a 0. Total the numbers for the 3 habitat features. The value from the total will determine the classification of the overall habitat.

Using these three levels of classification described above to stratify for analysis provides a large number of unique groupings. This may result in small sample sizes for each habitat type, which

would make meaningful comparisons difficult. Grouping classifications before analysis may help alleviate this problem.

OBSERVATION METHODS

Personnel

For consistency, the number of crewmembers should remain the same throughout the study, ideally utilizing the same individual(s). One person can conduct BVIS or ENVIS, but an additional person may assist in data recording during surveys. If a one-person crew is used, the surveyor should carry a two-way radio at all times in case of an emergency.

At least one crewmember should have a professional background in wildlife biology or a related field, and be considered a skilled wildlife technician with an understanding and appreciation of experimental design, survey protocols, and accurate data recording. All crew members must have training in the survey protocol and in accurate data recording. Important consideration is for an individual to have good vision and physical stamina to work in difficult terrain and possibly ford streams.

Establishing Observation Points

Stream sampling areas must be conducted after winter rains and spring runoff have decreased, and flows have dropped to allow observation of aquatic habitat conditions. It would be best to establish sites in summer or early fall, and sample the following year. This may not always be possible. At a minimum, establish sites prior to the day of survey. Sample areas should be visited and marked to identify observation points for relocation. Record the exact coordinates of observation points by using a quality map or GPS, and document how to relocate the point and how to minimize any disturbance when returning.

The procedures to establish observation points are designed to provide the surveyor with flexibility in selecting suitable locations. This is necessary because *purely* random geographic selections of observation points are unlikely to result in the selection of appropriate sites for observation. Once boundaries of a sample area are identified, the observation point may be selected. For riverine sites, each selected point represents the lower (downstream) boundary of the potential sample point. The actual observation point will be selected at the first accessible location with suitable habitat quality that is at or upstream from the beginning point. The protocol for ponds is similar, with the sample area being the entire shoreline. The observation point should be selected from a location within the sample area that provides a wide view of the body of water. A small amount of movement around this point (10-20 m) may be needed to avoid obstructions and to fully view the sample area.

Select observation points that contain physical features that will facilitate and maximize turtle viewing opportunities. The availability of basking sites (*e.g.*, emergent rocks, logs) is probably the most important feature. In streams and rivers, attempt to select observation points that overlook pool habitats. Although the NWPT moves through all types of stream habitats, most time is spent in deep pools or areas with heavy cover, and NWPTs rarely occur in riffle environments (Reese

1998, Bury 1972).

Field Observation Techniques

Western pond turtles have excellent vision and hearing, and readily leave basking sites at the first sight or sound of danger (Bury 1972, Holland 1985, Holland 1994). Turtles are able to remain submerged in aquatic refuges for periods longer than the duration of the survey. Thus, observers need to adopt measures that do not frighten turtles. Observers should not wear brightly colored clothing. Move slowly when approaching a basking area, and hide behind available cover when approaching an observation point. If you are approaching in the open, move directly towards the turtles rather than sideways. Turtles seem less disturbed if you approach from a bluff or above the basking area rather than walking up to a stream or a pond at the same level. Communicate with other observers by signing or in hushed tones. Where possible, observers should stay a minimum of 50 m from basking turtles. Standard 8 x 40 binoculars with a field of view ranging within 350-450 ft at 1000 yds should be used in all observation efforts. To maintain consistency between sites, higher power ocular instruments should not be used to determine turtle numbers. Higher power instruments such as spotting scopes may be used to determine species, size, or sex but any additional turtles observed should not be included in the final count. Sunlight must be reaching the water for detectability and basking activities to occur.

Disturbances caused by humans (including the surveyor) or animals (wild or domestic) during the survey period invalidates the effort, and the survey visit should be abandoned and reinitiated after waiting at least one hour. Some high use areas may have disturbance present the majority of the time, these areas may need to be surveyed during low use periods. Recording the flight distance when a disturbance occurs may be useful in making future decisions about the establishment of observation points, and should allow surveyors to develop a greater awareness of acceptable observation distances.

Surveyors should first scan basking sites (logs, brush piles, large rocks, boulders) and then the shoreline, especially checking any brush or vegetation. Non-adults often bask in shallows and singly, whereas adults tend to congregate on larger objects and often in deeper water (Reese 1996). Boulders or logs away from shore are preferred basking sites. Next, scan the surface of the water for heads or noses that can often be seen at the surface of the water. Where there are algal mats, turtles may float on top of the vegetation, sometimes with only the top of the shell exposed. Some viewpoints may also allow scanning below the surface of the water for swimming or foraging turtles, but this is uncommon.

The count of turtles recorded at each site will be the maximum observed at any one time. This may occur at any time throughout the survey period. Set up an observation station at a good vantage location (e.g., behind cover or on an outcrop overlooking the water) within the survey point. For longer visits, a folding chair, clipboard, water, hat, etc. may be brought to the point, but use caution and do not disturb the turtles.

Observing basking turtles offers an opportunity to determine the peak periods of basking and to estimate size classes that may be useful for population structure analysis. The carapace length of gravid females tends to increase with increasing latitude (Holland 1994). The size of a

reproductive adult starts at approximately 115 mm in southern California and 135 mm in Oregon. Thus, by sexing and estimating sizes of turtles, it may be possible to determine crude size class structure.

DIURNAL AND SEASONAL OBSERVATION PERIOD (BVIS AND ENVIS)

The sequential order of sample site visits for the entire study area should be randomized. While a randomized ordering scheme is not the most efficient means of conducting surveys, biases caused by temporal variance in activity levels will be reduced. If a completely randomized order is not logistically possible, select the first site on the random sequence, and then any eligible sites in proximity to that site may be selected.

The observation period in northern latitudes is between 1 April and 31 September when surface water temperatures are at or above 10° C. It has been determined for northern latitudes that the optimal season for observing turtles occurs earlier in the year at pond sites compared to riverine sites (Horn unpub data). The observation period in southern areas such as the Sacramento Valley should emphasize early spring before the temperatures become too hot. The best observation period will vary between drainages and between years. Time spent in atmospheric basking often decreases as summer progresses (e.g., time to reach elevated body temperatures is less in higher ambient temperatures and warmer water lessens the need for basking time out of the water).

Initiation of each visit should occur on warm, sunny days when turtles are visible on rocks, logs, or other emergent sites. The use of a 5-hour "sliding window" observation period will allow the greatest flexibility for rangewide surveys. In hot weather during mid summer, avoid surveying in the afternoon hours since peak basking occurs in mid-mornings (Bury 1972, Todd 1999). Observe later in the day during spring and fall in the northern latitudes, and earlier in the day during summer or in southern latitudes. Conduct at least one morning visit when the surface of the water is first exposed to direct sunlight. Since this time will vary by site, it is best to establish the time prior to initiation of surveys. Attempt to vary the time of day when each successive visit is conducted.

An example of a schedule for visits to randomly selected pond and riverine sites is as follows:

1. Begin surveys to pond sites in April and May from 1000 – 1500 hr.
2. Continue surveys to pond sites in June, but begin earlier in the day from 0900 – 1400 hr.
3. Complete pond surveys if needed in July and August from 0800 – 1300 hr.
4. Begin riverine surveys later in the season than pond surveys, begin riverine surveys in late May and June from 0900 – 1400 hr.
5. Continue riverine surveys in July and August from 0800 – 1300 hr.
6. Complete riverine surveys if needed in September from 0900 – 1400 hr.

BASIC VISUAL SURVEYS (BVIS)

Sites are selected for the BVIS following guidelines in the Selection of Sample Area and the Selection of Sample Sites sections. Within the BVIS, two different intensities of surveys are possible: a large number of points searched for 15 minutes each (visual point count), and a greater

number of points for shorter time period (floating surveys). The short observation period of both point counts and floating surveys should allow many sites to be visited, enabling establishment of extensive basin-wide distribution data. The visual point surveys are relatively easy to establish and are broadly comparable between geographic areas.

A point survey may be conducted as soon as the following day after the establishment of an observation point, but would be better if delayed a week or more to be sure turtles are undisturbed. Use the techniques as described in the Observation Methods section. One person using binoculars will observe for a total of 15 minutes per site. Record the maximum number of turtles observed at any time, and record separately the adult and non-adult sizes. Record all information on the data forms provided in appendix I. Each site selected for a survey will be visited until turtles are observed, for a maximum of three visits. Repeat visits to a site should occur at least 1 day apart and preferably a week apart. No trapping should occur within 1 week prior to survey visits.

A floating river survey is probably the most extensive survey possible per unit effort, since both banks are covered and there are virtually no gaps in river coverage. For streams with limited access from the bank, this method allows complete coverage. If desired, randomly chosen beginning points may be established that can be repeatable in subsequent years. However, the beginning and ending point will be dependent on river access locations. We recommend a minimum distance of 8 km (5 miles) for each reach floated. Record all major areas with turtles, collecting the same data as in the 15-minute surveys. The floating survey can also be used to survey large ponds. The floating survey requires additional training, skill and attention to safety compared to the point surveys.

The river survey may employ 2 methods: a motorized boat or human-propelled boat (e.g., an inflatable kayak). The motorized boat may work best on large ponds and large rivers and the inflatable kayak (or similar craft) may be more practical on smaller rivers.

ENHANCED VISUAL SURVEYS (ENVIS)

Sites are selected for the ENVIS following guidelines in the Selection of Sample Area and the Selection of Sample Sites sections. If BVIS observation points have been established, a subset of the sample areas may be randomly selected for more intensive ENVIS surveys. Use the techniques as described in the Observation Methods section. One person using binoculars for a total of 35 minutes per site will conduct observations. Record the maximum number of turtles observed at any time, and record separately the adult and non-adult sizes. Record all information on the data forms provided in appendix I. To maintain consistency, survey each site at least 3 times per year for 2 years. Repeat visits to a site should be at least 7 days apart and preferably 2 weeks apart. No trapping should occur within 1 week prior to survey visits. Attempt to conduct all three yearly replications in spring or early summer, the third survey may be conducted in late summer or early fall if necessary. Follow the guidance given in the Diurnal and Seasonal Observation Period (BVIS and ENVIS) section when determining survey periods.

IX. MONITORING BY TRAPPING SURVEYS

The purpose of monitoring by trapping is to assess the current situation and the trends in population demographics, such as population size, sex ratio, growth rate, survival, recruitment, and fecundity. Many of these important population parameters are not measurable with visual surveys (Holland 1994, Germano and Bury 2000). More intensive effort is required for monitoring by trapping, but it is a useful expenditure of effort to validate and calibrate results from visual results. The use of both visual and capture methods may be needed for timely detection of trends and threats to populations.

SAMPLE METHODS

Selection of sites to trap may occur in two ways: (1) a sub-sample of the areas randomly chosen for visual surveys, and (2) areas where site-specific demographic data is required. The sub-sample method is useful in areas with visual surveys where the data may be used to correlate the number observed with the number captured. It is also useful for the systematic gathering of data where NWPT habitat or populations are suspected to be in serious decline. The site-specific method may be more useful in areas considered important as population sources or to the distribution of NWPT. It should also be used to monitor the efficacy of mitigation in project areas.

Ponds

At each pond site, trapping will be used as the primary technique to capture NWPTs. This trapping protocol provides a consistent and repeatable method to minimize differences in effort and allow greater comparison between sites and river basins. We suggest short bursts of trapping (4 nights minimum) with as many traps as are available.

Streams And Rivers

Sampling of riverine habitats generally requires snorkeling surveys since trapping appears to be ineffective in streams/rivers. However, snorkel surveys pose safety concerns, require divers that are trained, and the use of special techniques (see Monitoring by Snorkeling section). Although trapping in riverine situations is generally ineffective, it may be the only option in some situations where there are safety concerns (e.g., murky water, obvious hazards) or a lack of qualified divers.

Disturbance

Disturbance by observers at sites could affect the success of turtle captures. Limit the amount of time spent in the water when setting and checking traps. Avoid having large numbers of people at the site and leave the area promptly once the traps have been set. Areas where recreational use is high should be avoided because traps may be stolen, or vandalized. Sometimes, recreational use is concentrated on weekends, therefore trapping during mid-week may be desirable at these sites.

TRAPPING TECHNIQUES

Replications

Trapping effort must be a minimum of 1 trap replication (at least 4 trap nights X 6 turtle traps) since the probability of capture is usually quite low. An additional trap event is recommended 2-4 weeks later. Some turtles avoid traps once caught or some turtles may temporarily emigrate from

their site of capture. There is also evidence that turtles may readily escape from funnel traps (Horn unpub data). No trapping should occur within 1 week prior to visual surveys. For consistency, trapping sessions should be scheduled following the completion of basic visual surveys (BVIS) or enhanced visual surveys (ENVIS). This will provide the greatest time interval between trapping and the next visual observation period.

Trap Density and Placement

In general, set each trap at about 10 m intervals along the shoreline and set at least 6 traps per site. Trap spacing may be reduced to 5 m apart in areas of dense cover. In large waters, it may only be possible to trap one bay. For these larger waters, we recommend trapping several areas (e.g., 2-3 bays). If the number of traps is limited, trap each area during successive time periods and consider the entire effort to be 1 trap replication.

Place the traps in or near cover and near basking sites (e.g., floating logs, brush piles, vegetated shoals, rocky points). In streams, place the traps upstream from basking sites within pools. Attempt to locate the trap in slow water near bank overhangs or in cover that creates backwaters.

Special care is needed to ensure the top of the traps remain above water to allow captured turtles to surface for air. Traps must be secured by rope to a solid anchor (e.g., boulder, tree trunk). We recommend the use of dark-colored rope and painting of the floats brown or black to help conceal them. It is useful to produce a drawing showing the exact location of traps so that all traps can be relocated rapidly on the return visit. Traps should not be left unattended in areas where there is a reasonable likelihood of human tampering. Delay or cancel any capture effort during heavy precipitation to reduce the risk of high water that may drown turtles or sweep traps away.

Set and Check Times

Set the traps out between 1600 and 1800 h in the evening and check traps between 0700 and 0900 h the next morning. Allow for several hours of daylight capture effort after setting the traps, and allow for several hours of daylight capture effort in the morning before checking the traps. It is best to check the traps again midday (e.g., 1300-1400), and partial rebait (e.g., add a small amount of bait directly into the trap or squeeze the bait can). Some people add a small amount of bait or rebait all traps each evening. Canned sardines in oil work well as a bait, but may become somewhat expensive for large trapping projects. You can purchase large cans of sardines, and then make bait boxes to put smaller portions in each trap. Other baits include canned mackerel, fresh fish, or even creamed corn (Voorhees 1991).

Determining the catch per unit effort requires a definitive set and pull time. The simplest method is to record the average times for setting the traps and the average times for pulling the traps. Traps must be checked at least every 15 hours to reduce the chances of turtle mortality and to reduce the rate of turtle escapement.

Threat of Mortality

Trapping can create risks to NWPTs especially if improperly performed. Turtle drowning occurs due to traps placed too deep in the water, poorly secured to the shoreline, public curiosity, or vandalism. These risks can be minimized or eliminated. First, use floats on traps set in deep water

(i.e., if the trap is not resting on the bottom) to ensure there will be enough space above the water surface to allow captured turtles to surface for air. Consider using floats even in shallow water since traps may move and the water level may fluctuate. Other precautions that minimize risks include remaining at the site (e.g., 50-100 m away) during trap hours in areas used by humans, using signs to provide public information, field training in proper trap use, equipment sanitation (Appendix G), and the proper handling of NWPT.

TRAP DESIGNS

Currently, one of the most effective traps is a design using a lightweight, small trap (ca. 0.6 m long) with funnels allowing easy turtle entry, but difficult exit (Holte 1998). An adaptation has been developed which uses PVC pipes as support for the netting and for floatation. Turtle traps can be purchased from commercial fisheries suppliers (mostly in the eastern U.S.), but these often are large-sized (e.g., 2-3 m long) and heavy (e.g., 1-m diameter metal hoops). There are many designs, and most seem to catch turtles. Traps need to be constructed so that there are no loose areas or loose ends that could entangle and drown turtles. An adaptation to the funnels which uses a one way door should be experimented with in an attempt to reduce turtle escapement.

X. MONITORING BY SNORKELING SURVEYS

Snorkeling is the most effective technique to sample riverine habitats and has been widely used (Bury 1972, Holland 1994, Reese 1998, Todd 1999). Snorkel surveys depend on experience and skill, and consistency varies between divers therefore comparisons between areas should be viewed with caution (especially when new divers are used). The purpose of monitoring by snorkeling is the same as monitoring by trapping, to determine population parameters not measurable with visual surveys.

SAFETY

Safety is extremely important when using snorkeling as a capture method. Prior to any sample effort, the surveyor should be experienced at snorkeling or trained to snorkel safely and efficiently. The crew should have a two-way radio at all times in case of an emergency. Basic life saving training is recommended. Always carry a first-aid kit. Streams and rivers may have barbed wire, broken glass, and other sharp objects present, especially near bridges. Thus, feel lightly under objects to avoid injury. The work demands the ability to free dive under objects and feel with your hands, similar to becoming a river otter. There must be two surveyors present at all times, and be particularly attentive when searching near large woody debris (which could roll or fall). The diver may choose to push against objects prior to diving under them to ensure the object is secure and will not move.

SEARCH TECHNIQUES

Two divers always work together for safety and efficiency. They should alternate diving times. While one person is diving, the other person should be resting (standing nearby the diver) and ready to assist when needed. The standby person should have a mesh bag(s) to hold captured

turtles, which helps to free the hands of the diver.

Start at the lower reach of suitable habitat (e.g., a pool in a stream) and systematically work upstream. The search method depends on the depth of the water and whether pools or riffles are being searched. Use both a visual search under objects and a tactile search with your hands in crevices. For deep pools, search basking sites and the surface of the water for the heads of turtles; if they are observed, dive where the turtle was last seen and feel for the turtle. Search in undercuts or under large boulders or rocks, you will need to use your hands to search in many places since stirring up sediment will reduce visibility. Use slow "windshield wiper" arm movements when in vegetation or mud.

Divers can walk shallow riffles and search under hummocks with their hands and visually search into the water. However, it is more effective to float through the riffle and probe with your hands (this allows a longer reach into crevices) rather than to walk and reach under objects (Bury, pers. obs.). Make sure not to miss side channels and backpools, since turtles will often be congregated in those microhabitats.

XI. FIELD PROCEDURES FOR CAPTURES

PERMITS

A Scientific Taking Permit from each state wildlife agency is required to capture NWPTs. Anyone applying for a permit must ensure proper training is provided to all who will assist in trapping efforts. Other special permits are required on certain federal lands (e.g., National Parks) and other areas (e.g., state parks, private timber lands). Always check first with the landowner before initiating a trapping effort.

EQUIPMENT SANITATION

To avoid the introduction of disease or non-indigenous species into unaffected sites, traps and other equipment used in turtle trapping or marking must be thoroughly cleaned and sanitized when moving between basins. If there is a suspected die-off or disease at a site, you should be even more cautious and thoroughly clean equipment before moving to each new site. Traps need to be cleaned of all animal and vegetative material, and then set in the sun or cleaned with a diluted chlorine solution. When available, it may be convenient to clean traps at commercial car washes using power sprays. Equipment used in measuring and marking should be rinsed in a mild disinfectant.

HANDLING OF TURTLES

Wear latex gloves or other rubber gloves when handling turtles to protect yourself and also to prevent the transmission of disease between turtles. Use standard sanitary techniques because turtles are capable of transmitting forms of bacteria, fungus and internal parasites to humans

(Appendix G).

Handle turtles as little as possible, the presence of 2 people is preferred since it allows one to hold the turtle and take measurements while the other records data. Hold the turtle firmly by the shell and with two hands whenever possible. NWPTs rarely bite, but they have sharp claws and may struggle to free themselves. They may cause abrasions to handlers, but the handler must hold the turtle firmly and not drop the turtle. Complete all marking and measurements, and release the turtles as soon as possible. Do not hold turtles beyond the day they were captured.

Turtles should be kept in open containers with high sides, such as 5 gallon plastic buckets. Put about 2-5 cm of water in the bottom and keep captured turtles out of direct sunlight since overheating is possible in a short time. Limit the number of turtles placed into each bucket. If 5 gallon buckets are used, do not put more than 5 turtles in each, if possible put only one turtle in each bucket. Keep large and small turtles separate to avoid injury to smaller individuals. Return and release all turtles at the point of capture after measuring and marking procedures are complete. *NOTE: Do not mix turtles from different sites.*

MEASUREMENTS

Carapace Length

Use large sliding calipers that are available at most logging supply stores. They are cheaper than dial micrometers, and fit well across the top and bottom of the carapace and plastron so that the longest points of the carapace are easily and accurately measured. Most people only record the maximum carapace length (CL) but biologists regularly take other measurements (Appendix D).

Weight

Have several calibrations of scales (100g and 1kg Pesola spring scales are a common type) present to record the weight of turtles in the field. An "alligator" clamp can be attached directly to the carapace at the dorsal end of smaller turtles or use a small mesh bag that can be rinsed and sanitized after each use for larger turtles (remember to deduct the weight of the bag). If using a clamp, hold the turtle over a soft surface to prevent injury if the clamp releases and the turtle drops.

Gravid Females

If fecundity data is needed, hold the female turtle by the back legs (one leg in each hand) and gently insert the forefinger of each hand into the abdominal cavity of the turtle. Gently feel for oviducal eggs, if present they will be easily detected as hard lumps. It is best to use two people, one to hold the turtle firmly and the other to gently push the head into the shell if it is extended.

Sex

The NWPT begins exhibiting sexual dimorphism in morphology and color when turtles are about 100-120 mm in carapace length (Appendix B). These features may be obscure in some turtles. Females have a more dome-shaped carapace than the males. Males have a concave or indented plastron, while the plastron of females is flat or slightly convex. The cloaca in females is usually located close to the edge of the carapace or anterior to the edge, while the male's cloaca is located

at or posterior to the edge of the carapace. The tail of males is generally thicker in diameter and shorter than the tail of females. Males may have a light colored maxilla (the side of the head below the eye, including both sides of the mouth), light yellow or cream colored chin, and there is an angle to the profile of the mouth and nose (Holland 1994).

Age Estimate
Count the annuli (complete rings only) on the abdominal scute, the largest of the plates on the plastron (Appendix E). This technique is generally only useful on turtles <12 yrs of age. For studies of growth, you can measure the width of the annuli with calipers or prepare a plaster cast for later examination in the lab (Appendix E). Castings can be very useful for determining growth rates in this species (Bury and Germano, 1998).

Check for Marks (Codes)
Check along the marginal shields of the carapace for notches and if present, record the number indicated (Appendix D).

MARKING SYSTEM

Marking (notching along the outer scutes) is useful for estimating population demographics, and large samples are required to make valid inferences. Therefore, marking an occasional individual or at scattered sites adds little to the biological understanding of the species because recapture of these turtles is highly unlikely. Thus, we recommend only marking concentrations of individuals (e.g., in a defined area where there are 25 or more turtles present) rather than many individuals from scattered localities.

Adults and Non-adults > 70 mm
Using a small sanitized triangular file or half-round bastard file, cut a 3-4 mm deep "V" shaped notch into the center of the marginal scutes that correspond to the assigned number (Appendix D). The double notching of a single scute is not recommended due to the possibility of pieces of the carapace chipping out rendering the mark unreadable.

Hatchlings < 70 mm
Marking hatchlings poses some mortality risk due to their soft shells and fragility. The decision to mark hatchlings or year 1 turtles should take this risk into account. Hatchlings should only be marked where there is a valid long-term study. Recapture of 1-2 year olds is rare, and marking is recommended only for turtles 3 years old or older in northern populations (once the shell has hardened). Gibbons et al. (1990) have conducted one of the most intensive studies on any freshwater turtle (*Trachemys scripta*) and they began using turtles 3-4 yrs old for their demographic analyses.

If small turtles are to be marked, a relatively safe procedure is to use small cuticle or iridectomy scissors to snip a small triangular notch 1-1.5 mm deep (deeper can cause injury) from the center edge of the marginal scute. Roughen the edges of the cut very slightly with a small triangular file or emery board. Special numbers need to be reserved for hatchling marking, and will be specified by the State coordinator. Mark only the 1st and 2nd left and right marginals (Codes series 800,

400, 100, 200), and the 10th, 11th, and 12th left and right marginals (series 40, 30, 20, 10, 9, 8). Do not mark the marginals on the bridge (where the carapace and plastron meet) since this may result in injury to small turtles (Appendix D). When marked hatchlings are recaptured, it may be necessary to enlarge the original notches by re-filing (proportionate to the size of the turtle), which helps to ensure future number recognition.

Use silver nitrate (styptic pencil) to cauterize any observed wounds during marking and at the marking sites on scutes, especially with young turtles.

NUMBER (CODE) ASSIGNMENTS

Although NWPT rarely move great distances, coordination of the use of numerical marking numbers within and between states should occur. Investigators need to alert key contacts in each state to avoid duplication. Following are several possible contacts, the non game department of most state wildlife agencies should be able to assist.

Oregon
Number assignments for regions within the state are coordinated by the Oregon Dept. Fish and Wildlife, 7118 NE Vandenburg, Corvallis, Oregon 97330-9446 (Phone 541-757-4186), and then at their District levels. Only one marking system is allowed. The current direction from ODFW is that marking is allowed only for research projects. Mark and recapture data is to be reported annually to the coordinator. A statewide database has been established.

California
There is currently no official coordination of number assignments in California. However, before initiating any marking program, please avoid any duplication of numbers by contacting: Dr. Dan C. Holland, Camp Pendleton Amphibian & Reptile Survey, 334-A East Fallbrook, Fallbrook, CA 92028 (Phone 619-723-4404).

Washington
There is currently no official coordination of number assignments in Washington. However, before initiating any marking program, please avoid any duplication of numbers by contacting: Kate Slavens, Washington Dept. of Fish and Wildlife, 19339 20th Ave. NW, Seattle, WA 98177 (Phone 206-542-6751).

XII. NEST AREA SURVEY AND MONITORING

NEST HABITAT IDENTIFICATION

Nesting habitat is more specialized than other NWPT habitat, the location of potential habitat areas should be identified. Begin by identifying and delineating all non-forest habitats (10% or less tree canopy closure; with a significant grass, forb or shrub vegetative component) within 500 m of a perennial stream, lake or pond (this includes some seasonal ponds) using aerial photos at a scale of 1:12,000 or larger. Smaller scale photos such as 1:24,000 may not provide adequate enough detail for identification.

Assign a number to all potential habitat areas that need field surveys and enter the potential habitat locations into a Geographic Information System. This will assist in providing a permanent record of sites surveyed or those that need surveys. Complete site numbers should include UTM coordinates and a unique site extension number.

Visit the site and determine the site potential based on characteristics described in table 1, and if time is limited, eliminate sites with low nest potential from further field survey. Document your findings on the Nest Habitat Survey Form (Appendix I) and photograph the site.

Table 1. A general suitability index for nesting sites is as follows (Holland 1994, Holte 1998):

Feature	Nest Potential		
	High	Medium	Low
Aspect/exposure	S, W, SE, SW	NW, E	NE, N
Size of opening	>10 m^2		< 10 m^2
Vegetative cover	short grass/herb sparse	long grass/herb/shrub	shrub/tree
Soil	clay/silt		sand/silt
Slope (%)	0-30	30-60	60-100

SITE VISITS AND MONITORING PERIOD

In some areas, nesting areas are quite limited due to rare habitat components (e.g., open areas with southern exposure) and habitat loss. In addition, there are a number of threats to nest success such as predation on eggs and hatchlings, and a loss of connectivity between nesting and aquatic habitat (Holland 1994, Hayes et al 1999). A minimum of three nest areas per major river basin should be monitored annually for the number of nests, rates of predation and nest success.

Two to three site visits will be necessary depending on the results of each step as outlined below. The first monitoring period will occur between 1 June and 1 July in northern latitudes with specified timeframes for each site visit to assure confidence in the results. Nest searches must be conducted during morning or early afternoon hours (0800-1500 h) to avoid possible disturbance to nesting turtles (most nesting begins in the evening hours) (Holte 1998).

If a turtle is encountered at a nest site or in suitable habitat for nesting, back away and leave it alone. Return to the area later and thoroughly search for nests. Bring nothing which might attract predators (e.g., food or substances which might leave an odor) into any potential habitat area.

A second or third visit should occur between 15 June and 15 July. These visits are needed since recently excavated nests are the most obvious and easier to find than older nests. Also, additional

visits assure that the survey has occurred during the period of current nesting activity. Record any findings on the Nest Habitat Survey Form. If nesting is detected, complete the Nest Site Survey Form and describe the number and characteristics of any nests.

SEARCH GRID

A Basic Nest Survey covers a large area quickly by walking a 3 m^2 grid and searching for nests. Openings can be more intensively surveyed using an Enhanced Nest Survey by walking a grid block (1 m^2 grid size) and carefully searching for nests (Appendix F). This requires experienced surveyors who have developed a search image for intact nests.

Intact Nest Search

Gently poke and prod the ground at potential nest sites with your fingers, a small knife or a stick. If you are able to uplift a "clump" of soil somewhat circular in shape it will likely be the plug to a nest. Do not remove the plug and be careful to keep the plug intact and replace it exactly as you found it. Do not excavate or significantly disturb the soil. Evidence of previous years nests or preyed upon nests is also a good indication there may be intact nests present.

Disturbed Nests

Eggshell fragments are often observed near a current year's nest that has been excavated by a predator. Small, bright white shell fragments often are strewn about and the nest chamber is dug out. This will quickly confirm nesting in an area.

NEST CHARACTERISTICS

1. *Vegetation:* Compressed or flattened, 25-40 cm in diameter.
2. *Plug:* Earth and vegetation "kneaded" into a hole, if recent it may be moist.
3. *Cavity opening:* Circular or ovoid 35-45 mm in diameter.
4. *Chamber:* 80-110 mm deep, shape is like an inverted light bulb.
5. *Predation:* Shell fragments next to an excavated hole or disturbed surface.
6. *False scrapes:* Recent ground disturbance is present.
7. *Weather:* Nesting may be increased by recent precipitation.

MAP AND MARK NESTS

For annual nest location comparisons and relocation of nests for hatch emergence surveys, the location of nests should be accurately mapped and marked on the ground. Field flagging should be offset and discreet to prevent predators (e.g., foxes) or humans from learning the location of nests.

For the Enhanced Nest Survey, a 10 cm grid should be applied to the 1 m block grid and the location mapped. A similar process should be applied to the Basic Nest Survey where a 1 m grid should be applied to the 3 m block grid and the location mapped. Establish a reference point by using a compass and meter tape to mark the nest on the ground by placing a flagging pin directly north 1 m from nest. Document any necessary deviation from the reference point distance or azimuth.

LOCATING HATCHLINGS

Additional searches may be needed to detect hatchlings. The same techniques as described previously for nest searches are used, however the timing is different. Hatchlings often overwinter in the nest in northern populations, and usually emerge in late winter or early spring (Holte 1998). Emergence in the fall has been documented, but does not appear to be common. Documented emergence dates within the Willamette Valley range from 25 January to 24 March. Searching for hatchlings can be time-consuming work.

Escape proof exclosures can be used to protect the nest, but they should be searched often in the fall once rains begin, and then late winter through early spring. Hatchlings will emerge from the nest and bury themselves in the grass or duff within the exclosure.

VIII. IMPACT ASSESSMENT SURVEY

OBJECTIVES

To assess the impact of a project (e.g., construction of a new bridge or road) or management action on NWPT (e.g., control of weedy vegetation in ponds), a tested survey protocol provides information on species' occurrence and their habitats. This helps to develop mitigation and management recommendations for specific projects or activities. There are several purposes for this survey protocol:

1. To use consistent and reliable methods that are based on the most current knowledge of the species.
2. To determine the presence of NWPTs, estimate relative abundance, and provide baseline information on population and habitat condition.
3. To assess the impacts and monitor any changes to NWPT from a proposed project or management action.

PROTOCOL COMPONENTS

The NWPT survey protocol will be applied to habitat that meets the following criteria:

1. Elevation below 1370m (4500 ft) elevation.
2. All open streams or ponds (summer water temperature usually >10° C).
3. For potential nest habitat, open fields within 500 m of water.

We recommend three components of the survey protocol: (1) Determine if the project is within the suspected range, if yes continue; (2) Conduct aquatic and nesting habitat inventory, if habitat is present continue; and (3) Conduct species surveys.

HABITAT INVENTORY

A field habitat inventory is needed within and adjacent to the proposed project up to 0.5 km (0.31 mile) from the project or activity area boundary. This inventory is needed to describe and identify potential aquatic and terrestrial habitat of NWPTs, and to detect unmapped aquatic habitats such as wetlands and ponds. The field inventory records and maps several different features (see Site Habitat Data Form in Appendix I):

1. *Aquatic habitat*: Locations, type, depth, size, occurrence and frequency of basking sites, emergent vegetation, underwater refuge habitat, water flow and temperature.
2. *Terrestrial habitat*: Vegetation (forest, shrub, grass, forb, % canopy cover), non-vegetative components (soil, rock, % cover, slope and aspect). Characterize potential nesting and overwintering habitats.
3. *Roads*: Locations (especially relative to connectivity of aquatic and terrestrial habitat components); type, level, and season of use; and road density.
4. *Human development*: Locations; type, level, and season of use; and human density estimates within 1 km.

SPECIES SURVEYS

Visual Surveys

This survey is used where future monitoring of the project area is not likely to be needed. The visual observation survey is to determine the presence, relative abundance and size structure of turtles (adult:non-adult ratio).

Mark and Recapture by Trapping or Snorkeling

This survey is used where NWPTs are not detected during Visual Surveys. Employ the trapping protocol for ponds and marshes, and snorkeling for riverine habitats (but, be aware of needed safety precautions). Such surveys will likely detect the species, if present.

IX. LITERATURE CITED (Append with Conservation Strategy Lit)

Anderson, D. R., K. P. Burnham, A. B. Franklin, R. J. Gutierrez, E. D. Forsman, R. G. Anthony, G. C. White, and T. M. Shenk. 1999. A protocol for conflict resolution in analyzing emperical data related to natural resource controversies. Wildlife Society Bulletin 27(4):1050-1058.

Bury, R. B. 1972. Habits and home range of the pacific pond turtle, Clemmys marmorata, in a stream community. PhD Dissertation, University of California at Berkeley. 205 pp.

Bury, R. B. and D. J. Germano. 1998. Annual deposition of scute rings in the Western Pond Turtle, Clemmys marmorata. Chelonian Conservation and Biology. (3):108-109.

Germano, D. J. and R. B. Bury. 1998. Age determination in turtles: evidence of annual deposition of scute rings. Chelonian Conservation and Biology. (3):123-132.

Germano, D. J., R. B. Bury. 2000. Western pond turtles (*Clemmys marmorata*) in the Central Valley of California: status and population structure. USGS Species-At-Risk Program. 59 pp.

Gibbons, J. W. 1990. Life history of the slider turtle. Smithsonian Inst.

Hays, D. W., K. R. McAllister, S. A. Richardson, and D. W. Stinson. 1999. Draft Washington State recovery plan for the western pond turtle. Wash. Dept. Fish and Wild., Olympia, Wash. 53 pp.

Holland, D. C. 1985. An ecological and quantitative study of the Western Pond Turtle (*Clemmys marmorata*) in San Luis Obispo county, California. MA Thesis, California State University. 111 pp.

Holland, D. C. 1991a. A synopsis of the ecology and status of the Western Pond Turtle (Clemmys marmorata) in 1991. A report to the U. S. Fish and Wildlife Service, National Ecological Research Center, San Simeon, California. 141 pp.

Holland, D. C. 1994. The western pond turtle: Habitat and history. Report DOE/BP-62137-1, Bonneville Power Administration, Portland, OR. 302 pp.

Holland, D. C., and R. B. Bury. in press. *Clemmys marmorata* (Baird and Girard 1852) Western pond turtle. *In* P.C.H. Pritchard and A.G.J. Rhodin (eds.), Conservation Biology of Freshwater Turtles, Vol. II. Chelonian Research Monographs.

Holte, D. L. 1998. Nest site characteristics of the Western Pond Turtle, Clemmys marmorata, at Fern Ridge reservoir, in West Central Oregon. MS Thesis Oregon State University, 106 pp.

Horn, R. B. 2000. Umpqua River basin Oregon, pilot study for western pond turtle survey and monitoring. Unpub. Report. 39pp.

Jones, R. L., P. D. Hartfield. 1995. Population size and growth in the turtle *Graptemys oculifers*. J. Herpetol. 29:426-436.

Lindeman, P. V. 1997. A comparative spotting-scope study of the distribution and relative abundance of river cooters (Pseudemys concinna) in Western Kentucky and Southern Mississippi. Chelonian Conservation and Biology 2:378-383.

Lindeman, P. V. 1999. Surveys of basking map turtles *Graptemys spp.* In three river drainages and the importance of deadwood abundance. Biological Conservation 88:33-42.

Reese, D. A. 1996. Comparative demography and habitat use of Western Pond Turtles in northern California: The effects of damming and related alterations. PhD Dissertation, University of California at Berkely. 253 pp.

Reese, D., and H. H. Welsh, Jr. 1997.

Reese, D. A., H. H. Welsh. 1998. Comparative Demography of Clemmys marmorata Populations in the Trinity River of California in the Context of dam-induced Alterations. Journal of Hrepetology 32:505-515.

Todd, L. L. 1999. The ecology and habitat use of the northwestern pond turtle (Clemmys marmorata marmorata) in a lake in Southwestern Oregon. Masters Thesis, Portland State University. 180 pp.

Voorhees, W., J. Schnell, D. Edds. 1991. Bait preferences of semi-aquatic turtles in southeast Kansas. KHS Newsletter No. 85.